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NATIONAL DAM SAFETY PROGRAM, FRANK MILNE DAM (MO 11029), MISSOURI-ETC(U)
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FRANK MILNE DAM

HOLT COUNTY, MISSOURI

MO. 11029

**PHASE 1 INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM**

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FOR: STATE OF MISSOURI

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number) This report was prepared under the National Program of Inspection of Non-Federal Dams. This report assesses the general condition of the dam with respect to safety, based on available data and on visual inspection, to determine if the dam poses hazards to human life or property.		

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FRANK MILNE DAM
HOLT COUNTY, MISSOURI
MO. 11029

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

PREPARED BY
HOSKINS-WESTERN-SONDEREGGER, INC.
CONSULTING ENGINEERS
LINCOLN, NEBRASKA

UNDER DIRECTION OF
ST. LOUIS DISTRICT, CORPS OF ENGINEERS
FOR

GOVERNOR OF MISSOURI

MAY 1979

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ST. LOUIS, MISSOURI 63101

IN REPLY REFER TO

SUBJECT: Frank Milne Dam Phase I Inspection Report

This report presents the results of field inspection and evaluation of the Frank Milne Dam.

It was prepared under the National Program of Inspection of Non-Federal Dams.

This dam has been classified as unsafe, non-emergency by the St. Louis District as a result of the application of the following criteria:

- 1) Spillway will not pass 50 percent of the Probable Maximum Flood.
- 2) Overtopping could result in dam failure.
- 3) Dam failure significantly increases the hazard to loss of life downstream.

SIGNED

25 SEP 1979

SUBMITTED BY

Chief, Engineering Division

Date

APPROVED:

Colonel, CE, District Engineer

Date

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

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PHASE I REPORT
NATIONAL DAM SAFETY PROGRAM
ASSESSMENT SUMMARY

Name of Dam	Frank Milne Dam
State Located	Missouri
County Located	Holt County
Stream	Whales Creek
Date of Inspection	May 15, 1979

Frank Milne Dam was inspected by an interdisciplinary team of engineers from Hoskins-Western-Sonderegger, Inc. The purpose of the inspection was to make an assessment of the general conditions of the dam with respect to safety, based upon available data and visual inspection, in order to determine if the dam poses hazards to human life or property.

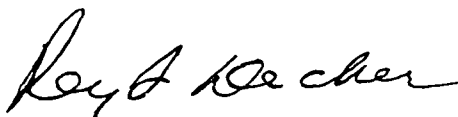
The guidelines used in the assessment were furnished by the Department of the Army, Office of the Chief of Engineers and developed with the help of several Federal and State agencies, professional engineering organizations, and private engineers. Based on these guidelines, this dam is classified as a small size dam with a high downstream hazard potential. Failure would threaten life and property. The estimated damage zone extends approximately three miles downstream of the dam. Within the damage zone are three dwellings, county roads and the Burlington Northern Railroad.

Our inspection and evaluation indicates that the spillway does not meet the criteria set forth in the recommended guidelines for a small dam having a high hazard potential. Considering the small volume of water impounded and the downstream hazards, one-half of the Probable Maximum Flood is the appropriate spillway design flood. The spillways will not pass the 100-year flood (flood having a one percent chance of being exceeded in any year) without overtopping the dam. The spillways will pass 5% of the Probable Maximum Flood without overtopping the dam. The Probable Maximum Flood (PMF) is defined as the flood that may be expected from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible in the region.

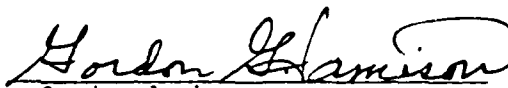
No design data were available for this dam. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency. These analyses should be obtained in the future.

Other than disintegration of the concrete pad at the outlet end of the principal spillway and the accumulation of trash around the principal spillway riser and at the entrance of the emergency spillway, no other deficiencies were found. The dam appears to be in excellent condition structurally.

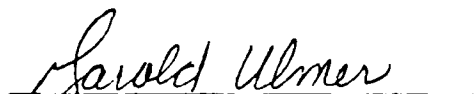
Maintenance concerned with the minor deficiencies described above and in more detail in the body of the report should be initiated by the owner. Action should be pursued immediately by the owner to increase the spillway capacity to handle the spillway design flood of 1/2 the probable maximum flood.



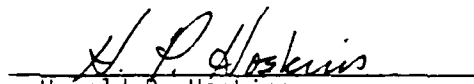
Rey S. Decker
E-3703



Gordon Jamison



Garold Ulmer
E-4777



Harold P. Hoskins
Chairman of Board
Hoskins-Western-Sonderegger, Inc.
E-8696



PHOTO NO. 1 - OVERVIEW FROM LEFT ABUTMENT

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM
FRANK MILNE DAM - MO 11029
HOLT COUNTY, MISSOURI
SECTION 1 - PROJECT INFORMATION

1.1 GENERAL

- a. Authority. The National Dam Inspection Act, Public Law 92-367, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a program of safety inspection of dams throughout the United States. Pursuant to the above, the St. Louis District, Corps of Engineers, District Engineer directed that a safety inspection of Frank Milne Dam be made.
- b. Purpose of Inspection. The purpose of the inspection was to make an assessment of the general condition of the dam with respect to safety, based upon available data and visual inspection, in order to determine if the dam poses hazards to human life or property.
- c. Evaluation Criteria. Criteria used to evaluate the dam were furnished by the Department of the Army, Office of the Chief of Engineers, in "Recommended Guidelines for Safety Inspection of Dams," Appendix D to "Report of the Chief of Engineers on the National Program of Inspection of Dams," dated May, 1975, and published by the Department of the Army, Office of the Chief of Engineers.

1.2 DESCRIPTION OF PROJECT

- a. Description of Dam and Appurtenances.
 - (1) The dam is an earth fill structure approximately 455 feet in length and 39 feet in height. It is located in the hill country adjacent to the Missouri River very close (0.5 mile \pm) to the river bluff line. Soils in the area consist of loess over glacial till on the uplands with glacial till and limestone exposures on the slopes.
 - (2) The principal spillway consists of a corrugated metal pipe and drop inlet riser located toward the left end of the dam. The principal spillway outlets into a scour hole the bottom of which is plated with limestone cobble.
 - (3) A vegetated earth emergency spillway is cut through

till and/or limestone on the left abutment.

(4) Pertinent physical data are given in paragraph 1.3 below.

- b. Location. The dam is located in the southern part of Holt County, Missouri, as shown on Plate A-2. The dam is shown on Plate A-1 in the SW $\frac{1}{4}$ of Section 19, T59N, R37W. The lake formed behind the dam is shown in the W $\frac{1}{2}$ of Section 19, T59N, R37W.
- c. Size Classification. Criteria for determining the size classification of dams and impoundments are presented in the guidelines referenced in paragraph 1.1c above. Based on these criteria, this dam and impoundment is in the small size category.
- d. Hazard Classification. Guidelines for determining hazard classification are presented in the same guidelines as referenced in paragraph 1.1c above. Based on referenced guidelines, this dam is in the High Hazard Classification. The estimated damage zone extends approximately three miles downstream of the dam. Within the damage zone are three dwellings, county roads, and the Burlington Northern Railroad.
- e. Ownership. The dam is owned by Frank Milne, Route 1, Oregon, Missouri 64473.
- f. Purpose of Dam. The dam was constructed primarily as a flood retardation structure.
- g. Design and Construction History. No preconstruction design information or detailed construction data are known to exist. It was reported by Mr. Wales, a nearby resident, that the dam was constructed in 1971 or 1972 as a group facilities project sponsored and cost-shared by the Holt County Agricultural Stabilization and Conservation Service (ASCS). Some technical assistance in design was provided by the Mound City ASCS office but all records have been discarded.
- h. Normal Operating Procedure. There are no controlled outlets for this dam.

1.3 PERTINENT DAM

- a. Drainage Area. 867 acres (1.35 square miles).

b. Discharge At Damsite.

- (1) All discharges at the damsite are through an uncontrolled corrugated metal drop inlet riser 6 feet in diameter with an elliptical corrugated metal pipe outlet and through an ungated, uncontrolled grassed earth channel cut through the left abutment.
- (2) Estimated maximum flood - unknown.
- (3) The principal spillway capacity varies from 0 cfs at elevation 890.0 to 124 cfs at elevation 895.2 (crest of the emergency spillway) to 128 cfs at elevation 897.0 (minimum top of dam).
- (4) The emergency spillway capacity varies from 0 cfs at its crest elevation 895.2 to 115 cfs at elevation 897.0 (minimum top of dam) to 690 cfs at elevation 899.5 (maximum top of dam).
- (5) Total spillway capacity at the minimum top of dam is 243 cfs \pm .

c. Elevations. (Feet above MSL)

- (1) Top of dam - 897.0 (minimum) - 899.5 (maximum)
- (2) Principal spillway crest - 890.0 \pm .
- (3) Emergency spillway crest - 895.0 \pm .
- (4) Streambed at centerline - unknown - water in plunge pool = 861 \pm .
- (5) Maximum tailwater - unknown.

d. Reservoir. Length (feet) of maximum pool - 1400 \pm

e. Storage (Acre-feet).

- (1) Top of dam - 64 \pm .
- (2) Principal spillway crest - 32 \pm .

f. Reservoir Surface (Acres).

- (1) Top of dam - 8 \pm .
- (2) Principal spillway crest - 3 \pm .

g. Dam.

- (1) Type - earth fill.
- (2) Length - 455 feet \pm .
- (3) Height - 39 feet \pm (possible maximum), 32 feet \pm flood plain (measured).
- (4) Top width - 18 feet \pm with rounded crest.
- (5) Side Slopes.
 - (a) Downstream - 2.9 to 3H on 1V (measured).
 - (b) Upstream - 4.6H on 1V (measured on exposure).
- (6) Zoning - unknown.
- (7) Impervious core - unknown.
- (8) Cutoff - unknown.
- (9) Grout curtain - unknown.
- (10) Wave protection - none.

h. Diversion Channel and Regulating Tunnel. None

i. Spillway.

(1) Principal

- (a) Type - uncontrolled corrugated metal drop inlet riser 6 feet in diameter and approximately 8 feet high connected with corrugated metal pipe conduit which was measured at the outlet end as 36 inches high by 54 inches in width (equivalent area = 40 inch diameter pipe)
- (b) Crest (invert) elevation - 890.0 feet \pm .
Outlet - 870 feet \pm
- (c) Length - 150 feet \pm

(2) Emergency

- (a) Type - uncontrolled vegetated earth cut through the left abutment.
- (b) Control section - vegetated earth approximately 48 feet in length normal to Q of dam and 20 feet in width.
- (c) Crest elevation - 895 feet \pm
- (d) Upstream Channel - vegetated earth, open
- (e) Downstream Channel - vegetated earth, open with exit slope of 20% \pm

j. Regulating Outlets. None.

SECTION 2 - ENGINEERING DATA

2.1 DESIGN

No design data were available for this dam.

2.2 CONSTRUCTION

No construction data were available. It was reported by Mr. Wales, a nearby resident, that the dam was constructed in 1971 or 1972.

2.3 OPERATION

No data were available on spillway operation.

2.4 EVALUATION

- a. Availability. No data were available.
- b. Adequacy. The field surveys and visual observation presented herein are considered adequate to support the conclusion of this report. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency. These seepage and stability analyses should be performed for appropriate loading conditions (including earthquake loads) and made a matter of record.
- c. Validity. Not applicable.

SECTION 3 - VISUAL INSPECTION

3.1 FINDINGS

a. General. A visual inspection of the Frank Milne Dam was made on May 15, 1979. Engineers from Hoskins-Western-Sonderegger, Inc., Lincoln, Nebraska making the inspection were: R.S. Decker, Geotechnical; Gordon Jamison, Hydrology, Garold Ulmer, Civil Engineer. The Owner was not present during the time of inspection.

b. Dam.

(1) Geology and Soils. (Abutment and embankment)

Hard, sound dolomitic limestone, probably of the Ervine of Plattsmouth formation, is exposed on both abutments at and slightly below the elevation of the top of the dam. The thin soil mantle on the abutments is moderately plastic clay (CL) of colluvial or residual origin. Soils on the surface of the dam are moderately plastic (CL).

(2) Upstream Slope.

The upstream slope is well vegetated with adapted grasses. Very little erosion was noted along the water line. No rodent holes, cracks or abnormal deformation were observed.

(3) Crest.

The crest of the dam is well vegetated with adapted grasses. Measurements along the crest indicate that the central portion is about 2 feet higher in elevation than the ends of the dam. The crest is rounded with indistinct upstream and downstream shoulders. No rodent holes, cracks or deformations were noted on the crest.

(4) Downstream Slope.

The downstream slope is well vegetated with adapted grasses. No indications of seepage were observed on the slope, at or below the toe or in the abutment troughs. No rodent holes, cracks, slumps or other deformations were noted on the downstream slope.

c. Appurtenant Structures.

- (1) The principal spillway consists of a 6 foot diameter corrugated metal riser about 8 feet high connected to a corrugated metal outlet conduit which probably has a diameter of 48 or 42 inches. (It was impossible to get down the riser to measure the conduit.) The outlet conduit is elliptical in shape at the lower end with horizontal axis of 54 inches and vertical axis of 36 inches. This deformation of the outlet end does not appear to have been caused by overloading and was probably in the pipe when installed. A hog wire mesh trash rack encircles the riser. Logs and trash have accumulated around the riser. A non-reinforced concrete pad was poured on the natural ground at the outlet end of the conduit, which is about 7 or 8 feet above the bottom of the plunge pool. The concrete pad is undercut and disintegrating into the stilling basin or plunge pool.

A very small flow of water was passing through the spillway when inspected.

- (2) The emergency spillway is cut through the left abutment. It is well vegetated. There was no indication of flow thru the spillway. Trash in the spillway entrance channel indicates that the reservoir level has been up to elevation 892 or 893.

Limestone bedrock (see Photo No. 5, Appendix B), is exposed in the left side of the spillway. It is not known whether or not the bedrock extends transversely under the control section of the spillway. No slumps or slides were observed in the spillway.

- (3) Drawdown Facilities - A 10 inch \pm slide gate is located on the reservoir (upstream) side of the riser. It is not known whether or not this gate is operable. (See Photo 8, Appendix B) but it appeared to be in good condition.

- d. Reservoir Area. The reservoir is surrounded by timber and grass. No significant erosion was noted around the shoreline. A deltaic deposit was observed around the inlet but the amount of siltation in the reservoir is not known.

- e. Downstream Channel. The bottom of the plunge pool for the principal spillway and the downstream channel bottom is plated with loose limestone rock. It was not apparent whether this rock plating was float rock or in-place bedrock, but the channel is open and seems quite stable.
- f. No evidence of overtopping was found by the inspection team.

3.2 EVALUATION

This dam appears to be in excellent condition structurally. Based upon the measured embankment slopes, the apparent nature of materials in the dam and the lack of seepage, the factors of safety against shear and piping or uplift failures must be fairly high. The few minor deficiencies in maintenance, concrete deterioration at the outlet of the pipe spillway and trash around the principal spillway riser and entrance to the emergency spillway do not seem to pose any serious potential of failure.

The apparent nature of embankment materials and the dense vegetative cover on the dam indicate that minor overtopping, such as the 10-year and 100-year floods, would cause little or no serious damage to this structure.

However, due to the fact that the spillways will pass only 5% of the probable maximum flood, frequent overtopping is possible. The dam crest should be raised or spillways enlarged to handle the standard design flood without overtopping.

SECTION 4 - OPERATIONAL PROCEDURES

4.1 PROCEDURES

There are no controlled outlet works for this dam. The pool level is controlled by rainfall, evaporation, and the capacity of the uncontrolled spillways.

4.2 MAINTENANCE OF DAM

The dense grass cover and lack of tree growth and rodent holes on the dam indicate that some degree of maintenance is carried on for this structure. The erosion at the outlet for the principal spillway should be corrected and removal of the trees and brush around the entrances to the spillways would increase their efficiency of operation.

4.3 MAINTENANCE OF OPERATING FACILITIES

The small gate into the principal spillway riser is the only operational facility for this dam. This facility was evidently installed to drawdown the reservoir level in case of emergency. It appeared that the gate is operable.

4.4 DESCRIPTION OF ANY WARNING SYSTEM IN EFFECT

Upon checking with the owner, there appears to be no warning system in effect for this dam.

4.5 EVALUATION

There does not appear to be any serious potential of failure of this structure. However, there is a serious deficiency in the capacity of the spillways in that they will only pass 5% of the PMF. There is a possibility of frequent overtopping.

SECTION 5 - HYDRAULIC/HYDROLOGIC

5.1 EVALUATION OF FEATURES

- a. Design Data. No design data were found for this dam. Therefore, all computations are based on the field inspection and survey performed by the consultant. The plans, profiles, and cross sections from the survey are attached in Appendix C.
- b. Experience Data. The drainage area, reservoir surface area, and elevation-storage data were developed from the USGS Forbes Missouri-Kansas, 7 1/2 minute topographic quadrangle maps. The hydraulic computations for the spillway and dam overtopping discharge ratings were based on data collected in the field at the time of the field inspection.
- c. Visual Observations.
 - (1) The principal spillway appeared to be in good condition. A trash rack composed of hog wire mesh encircled the riser and many logs and trash had accumulated around the inlet.
 - (2) The pipe outlet was elliptical in shape with a span of 54 inches and a rise of 36 inches. This deformation did not appear to have been caused by overloading but was probably in the pipe when installed. Corrugated metal pipe are not produced in elliptical shapes of this size and therefore the pipe is probably a deformed 42" or 48" diameter pipe.
 - (3) The outlet pipe rests on a non-reinforced concrete pad. The plunge pool was eroding and undercutting the concrete pad.
 - (4) The emergency spillway is located in the left abutment. Spillway use should not endanger the integrity of the dam.
 - (5) A 10-inch slide gate is located on the upstream side of the riser. It appeared to be in good condition, but it is not known whether or not it is operable.

- d. Overtopping Potential. The spillways are too small to pass 50% of the probable maximum flood without overtopping. Neither will the spillways pass the 100-year flood nor the 10-year flood. The 10-year just overtops the dam for a depth of 0.1 feet for less than an hour. The spillways will pass only 5% of the PMF without overtopping. Minor overtopping, such as the 10-year and 100-year floods, would cause little or no serious damage. The effect of overtopping from the 1/2 PMF is expected to be minimal.

The results of the routings through the dam are tabulated in regards to the following conditions.

<u>Frequency</u>	<u>Inflow Discharge c.f.s.</u>	<u>Outflow Discharge c.f.s.</u>	<u>Maximum Pool Elevation</u>	<u>Freeboard Top of Dam Min. Elev. 897.0</u>	<u>Time Dam Overtopping Hr.</u>
10 Yr.	670	270	897.1	-0.1	1
100 Yr.	1500	1400	898.8	-1.8	2±
1/2 PMF	4600	4600	900.2	-3.2	8±
PMF	9200	9200	901.5	-4.5	11+
0.05 PMF	460	190	896.4	+0.6	0

According to the recommended guidelines from the Department of the Army, Office of the Chief of Engineers, this dam is classified as having a high hazard rating and a small size. Therefore, the 1/2 PMF to the PMF is the test for the adequacy of the dam and its spillway.

The estimated damage zone is described in Paragraph 1.2d in this report.

SECTION 6 - STRUCTURAL STABILITY

6.1 EVALUATION OF STRUCTURAL STABILITY

- a. Visual Observation. The dam appears to be structurally stable. Factors of safety against shear failure and against excessive seepage or uplift are felt to be adequate. There were no seeps, slides or deformations noted on the embankment or abutments. Additional studies would be required to determine the effect of overtopping on structural or erosional stability. However, it appears that the safety of the dam would not be impaired by minor overtopping.
- b. Design and Construction Data. No design or construction data were available. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency.
- c. Operating Records. There are no controlled operating facilities for this dam.
- d. Post Construction Changes. The inspection team is not aware of any post-construction changes on this structure, and there was no evidence to indicate any post-construction changes.
- e. Seismic Stability. This dam is located in Seismic Zone 1. An earthquake of the magnitude predicted in this area is not expected to cause structural failure of this dam.

SECTION 7 - ASSESSMENT/REMEDIAL MEASURES

7.1 DAM ASSESSMENT

- a. Safety. The safety of this structure does not appear to be endangered. Using the approximate data available for analyses, the dam will be overtopped 3.2 feet for 8 hours by 50% of the PMF. The effect of such overtopping on the structural or erosional stability of the dam is expected to be minimal. The few minor deficiencies in maintenance reported in Sections 3 and 4 pose only a slight potential of failure of this dam.
- b. Adequacy of Information. Due to the lack of engineering data, the conclusions in this report are based upon performance history and visual observations. Seepage and stability analyses comparable to the requirements of the guidelines were not available which is considered a deficiency.
- c. Urgency. Overtopping can occur frequently if the spillway is not enlarged. The item recommended in paragraph 7.2.a should be pursued on a high priority basis.
- d. Necessity for Phase II. Phase II investigation is not considered necessary.
- e. Seismic Stability. This dam is located in Seismic Zone 1. An earthquake of this magnitude is not expected to be hazardous to this dam.

7.2 REMEDIAL MEASURES

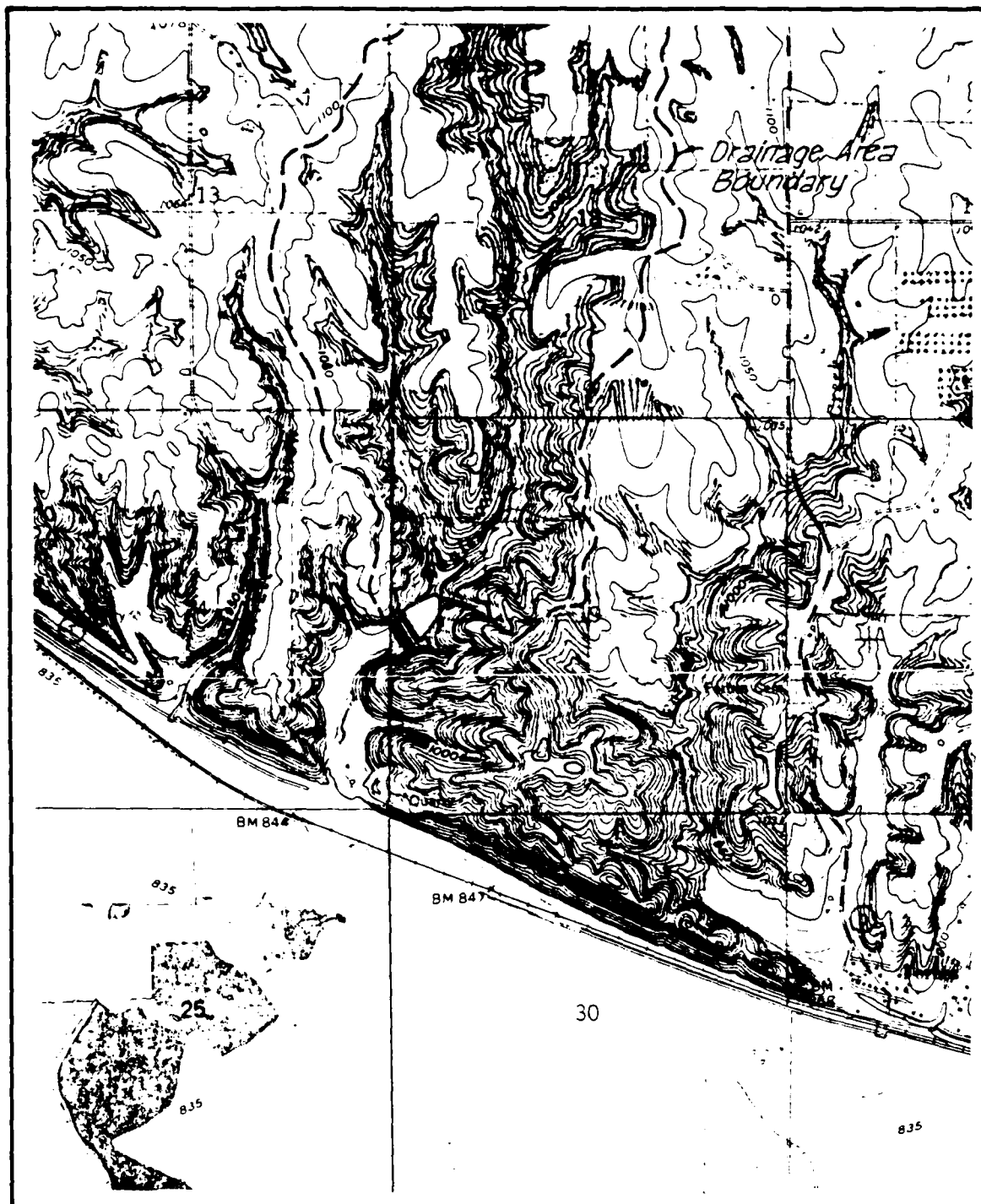
- a. Alternatives.
 - (1) Additional information should be obtained on the topographic characteristics of the reservoir area to determine the increase in the height of dam or the size of the spillway that is necessary to pass one half the Probable Maximum Flood without overtopping the dam.
 - (2) Leveling the top of the dam to the present maximum crest elevation would diminish the potential for overtopping.
 - (3) The services of an engineer experienced in the design and construction of earth dams should be obtained to evaluate the present reservoir storage capacity, to

provide seepage and stability analyses of the present dam, and to design protective measures, if required.

b. O & M Procedures.

- (1) Maintenance of this structure appears to be reasonably good.
- (2) The trees and brush should be removed from the spillway entrances and the erosional damage at the principal spillway outlet should be repaired. Regular inspections and measures to prevent recurrence of these minor deficiencies should be initiated.

APPENDIX A
MAPS



Scale in feet
2000 1000 0 2000 4000

Contour Interval 10 Feet



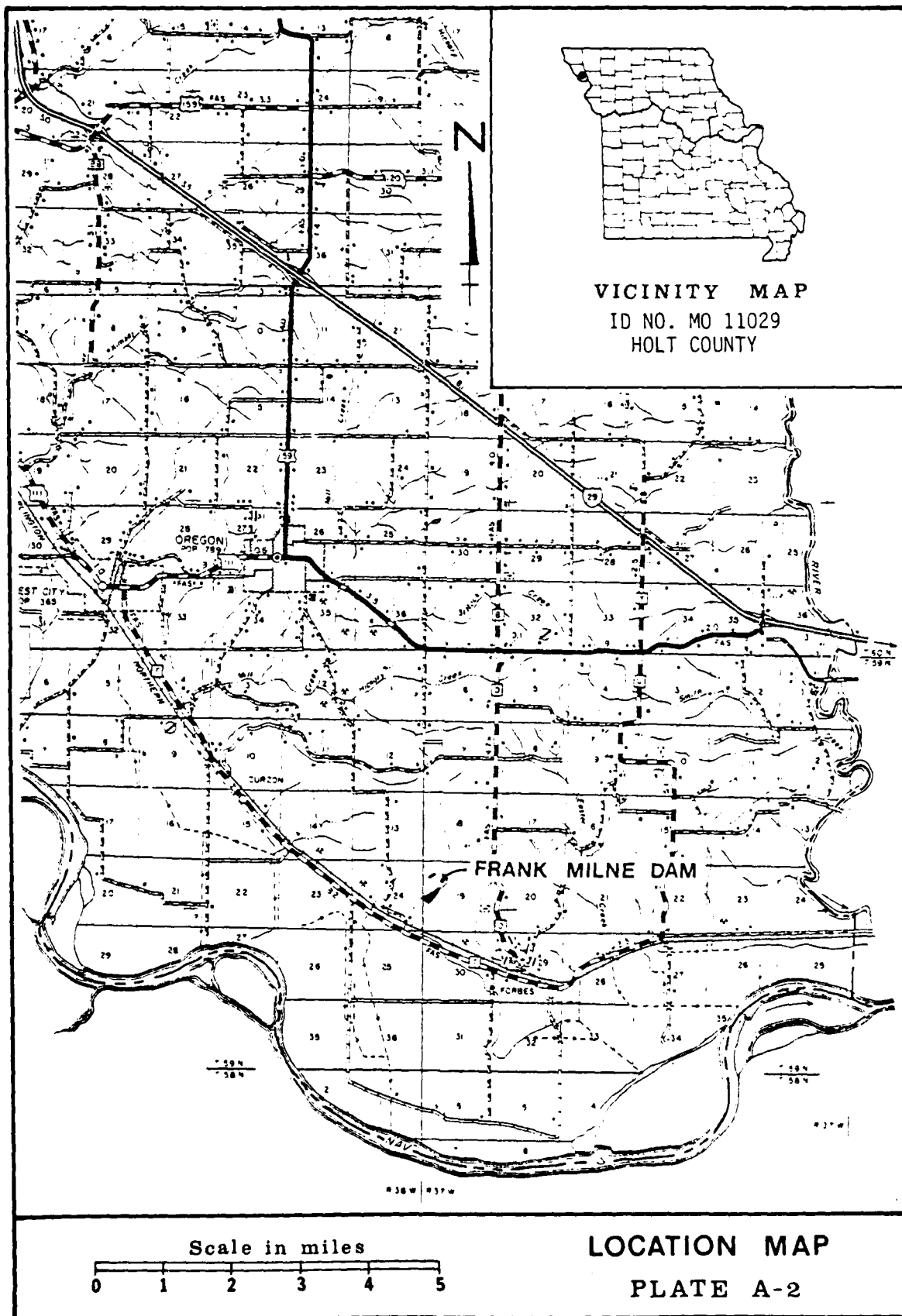
VICINITY TOPOGRAPHY

FRANK MILNE DAM

HOLT COUNTY, MISSOURI

MO. 11029

PLATE A-1



APPENDIX B
PHOTOGRAPHS

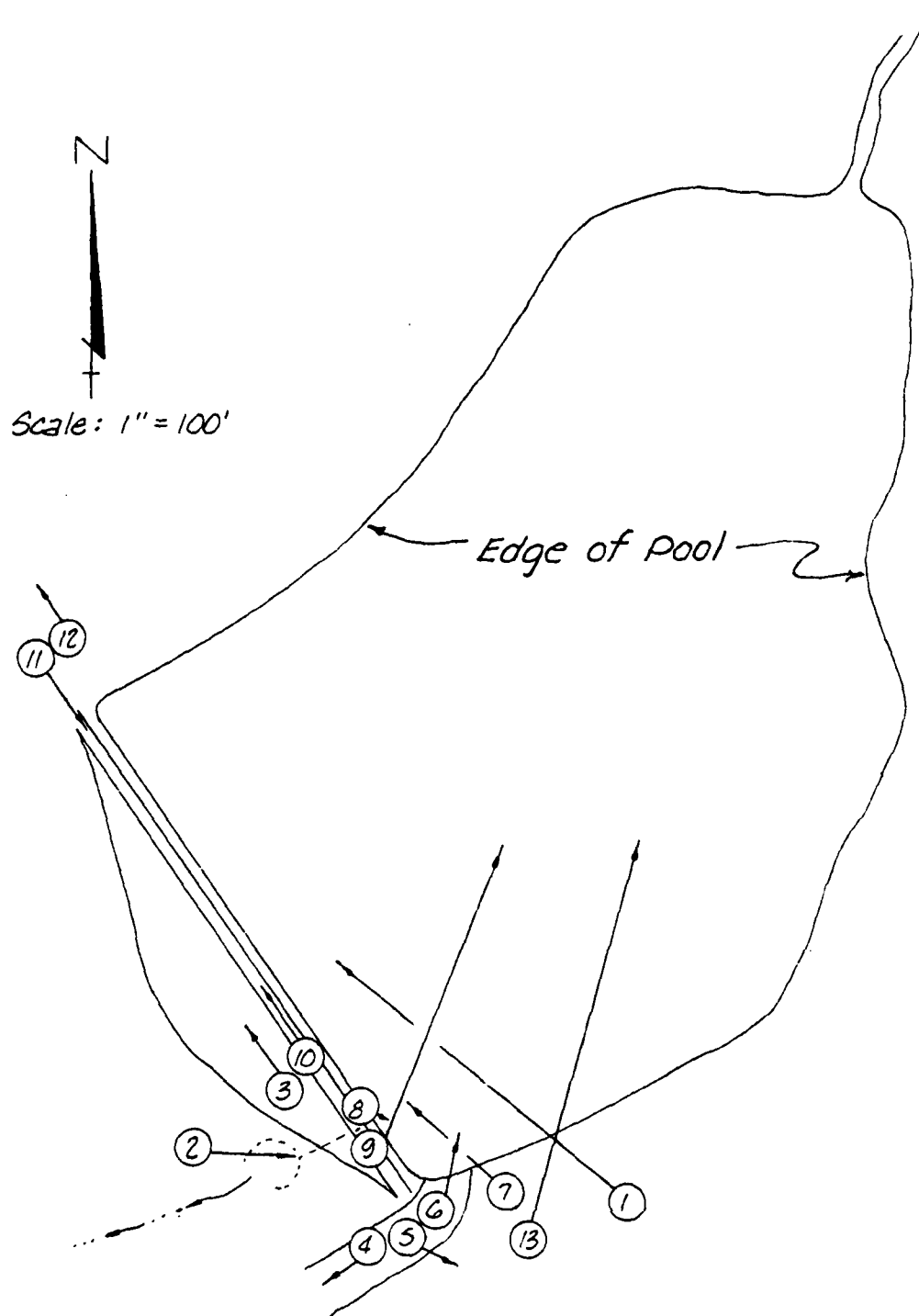


PHOTO INDEX

FRANK MILNE DAM

HOLT COUNTY, MISSOURI

MO. 11029

PLATE B-1



PHOTO NO. 2 - PRINCIPAL SPILLWAY OUTLET



PHOTO NO. 3 - DOWNSTREAM SLOPE



PHOTO NO. 4 - EXIT CHANNEL OF EMERGENCY SPILLWAY



PHOTO NO. 5 - LIMESTONE OUTCROP IN LEFT SIDE OF EMERGENCY
SPILLWAY



PHOTO NO. 6 - INLET CHANNEL OF EMERGENCY SPILLWAY



PHOTO NO. 7 - UPSTREAM SLOPE FROM LEFT SIDE SHOWING INLET
OF PRINCIPAL SPILLWAY RISER

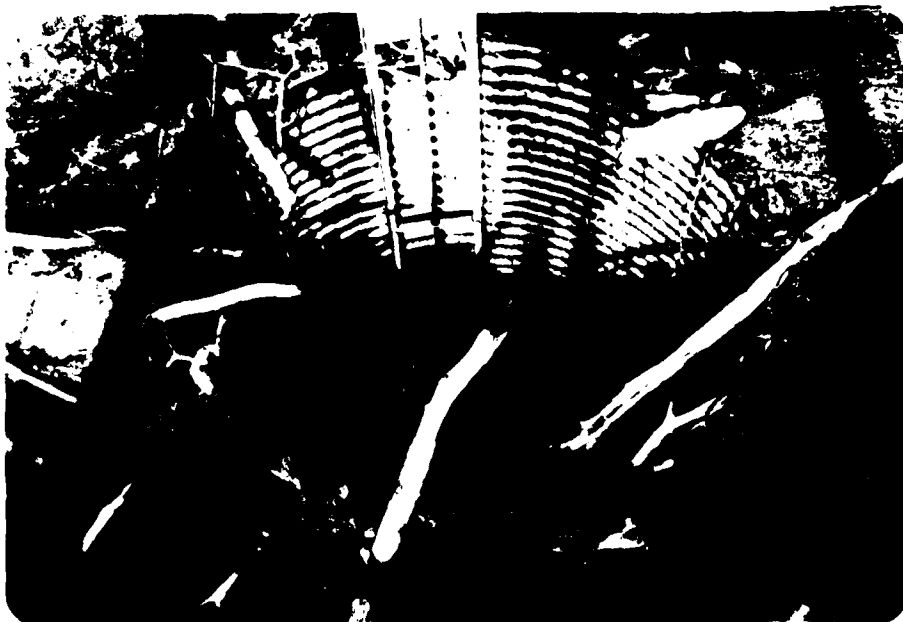


PHOTO NO. 8 - PRINCIPAL SPILLWAY RISER



PHOTO NO. 9 - LOOKING UPSTREAM FROM LEFT END



PHOTO NO. 10 - CREST OF DAM FROM LEFT END



PHOTO NO. 11 - UPSTREAM SLOPE FROM RIGHT END

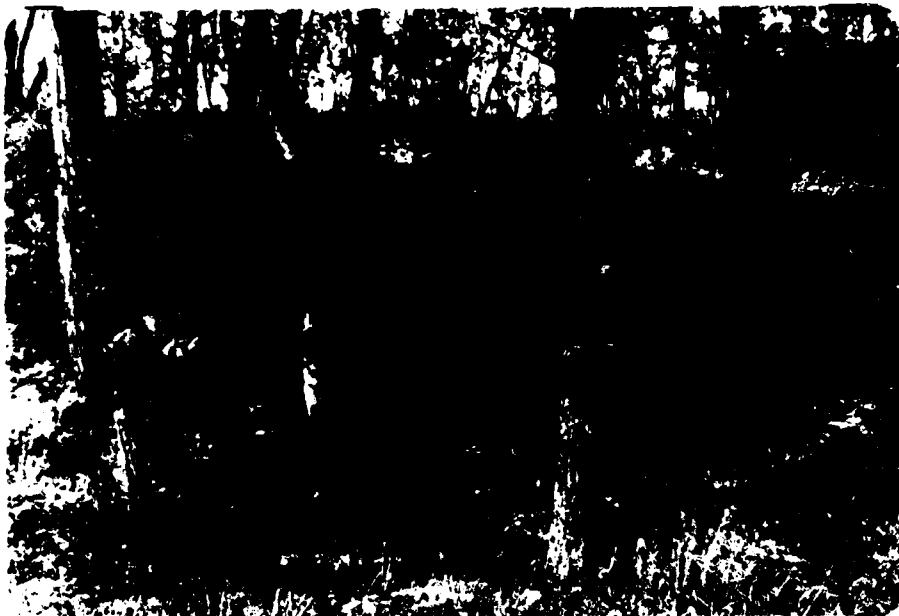
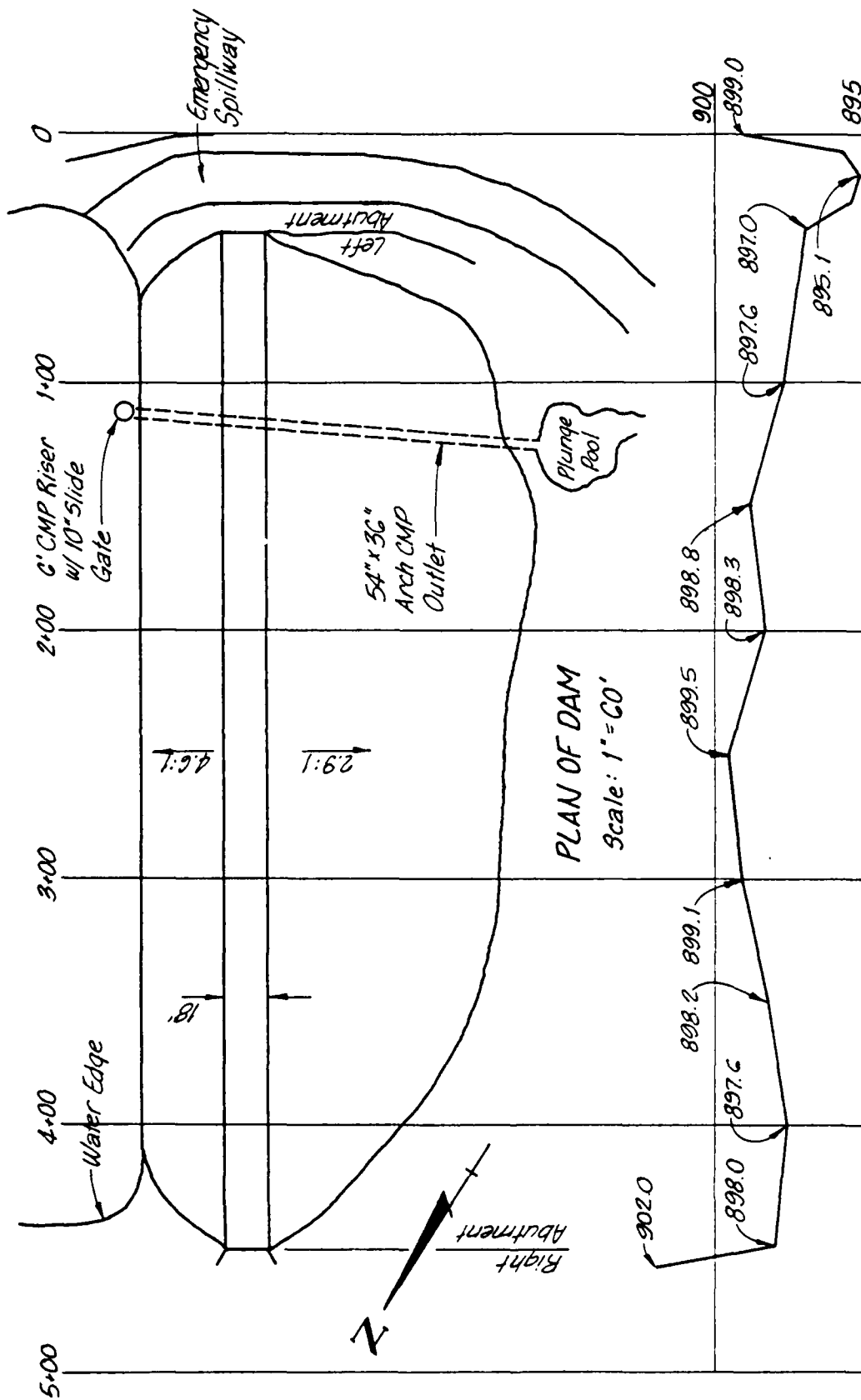


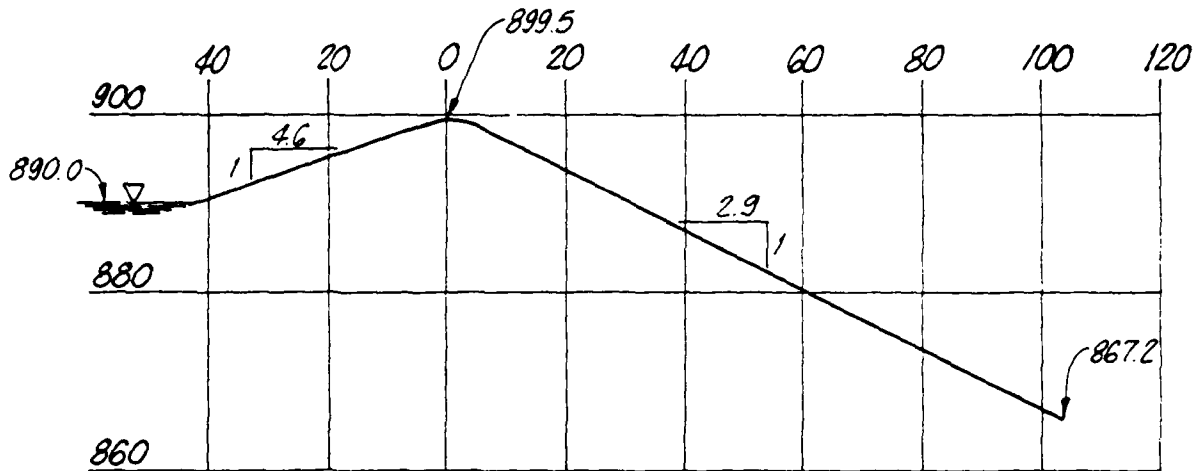
PHOTO NO. 12 - LIMESTONE EXPOSED IN RIGHT ABUTMENT



PHOTO NO. 13 - LOOKING UPSTREAM FROM LEFT ABUTMENT

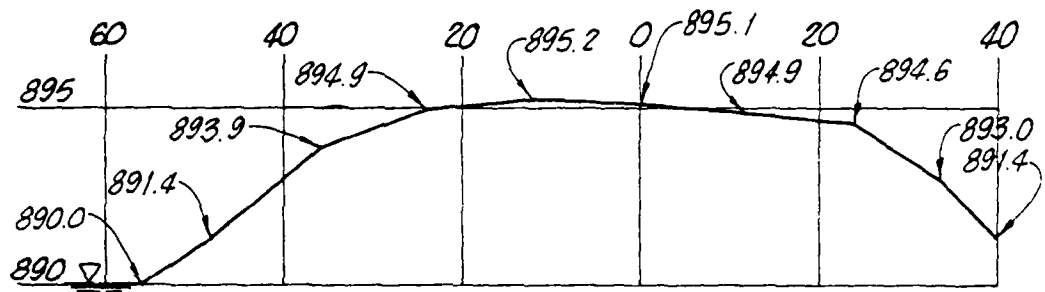
APPENDIX C
PROJECT PLATES





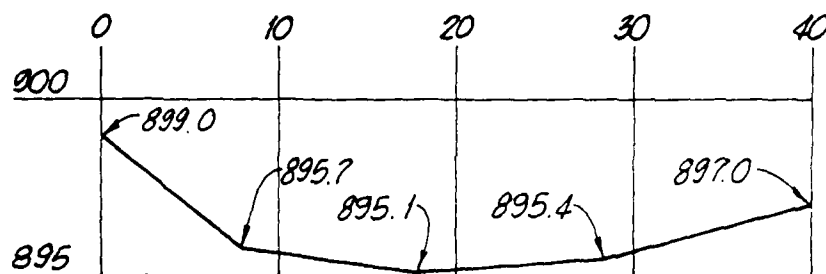
SECTION @ STA 2+50

Scale: 1" = 30' H.
1" = 20' V.



PROFILE OF SPILLWAY

Scale: 1" = 20' H.
1" = 5' V.



SPILLWAY SECTION (E of DAM)

Scale: 1" = 10' H.
1" = 5' V.

APPENDIX D
HYDRAULIC AND HYDROLOGIC DATA

HYDROLOGIC COMPUTATIONS

1. The SCS dimensionless unit hydrograph and the systemized computer program HEC-1 (Dam Safety Version), July 1978, prepared by the Hydrologic Engineering Center, U.S. Corps of Engineers, Davis, California, were used to develop the inflow hydrographs (See

a. Twenty-four hour, 100-year and 10-year rainfall for the dam location were taken from the data for the rainfall station at Maryville, Mo. as supplied by the St. Louis District, Corps of Engineers per their letter dated 6 March 1979. The twenty-four hour probable maximum precipitation was taken from the curves of Hydrometeorological Report No. 33 and current Corps of Engineers and St. Louis policy and guidance for hydraulics and hydrology.

b. Drainage area = 1.35 square miles (867 acres).

c. Time of concentration of runoff = 50 minutes (computed from "Kirpich" formula).

d. The antecedent storm conditions for the probable maximum precipitation were heavy rainfall and low temperatures which occurred on the previous 5 days (SCS AMC III). The antecedent storm conditions for the 100-year and 10-year precipitation were an average of the conditions which have preceded the occurrence of the maximum annual flood on numerous watersheds (SCS AMC II). The initial pool elevation was assumed at the invert of the principal spillway.

e. The total twenty-four hour storm duration losses for the 100-year storm were 3.63 inches. The total losses for the PMF storm were 3.15 inches. These data are based on SCS runoff curve No. 78 and No. 61 for antecedent moisture conditions SCS AMC III and AMC II respectively. The watershed is composed of SCS soil group B (Knox soils) and consists mostly of dense wooded areas with only 5 percent of watershed in cropland.

f. Average soil loss rates = 0.13 inch per hour approximately (for PMF storm, AMC III).

g. The stage-storage curve was developed from the quadrangle map mentioned in Section 5.1.b. Storage was computed by the HEC-1 program and checked by other methods. The stage-storage curve is included in this Section.

2. The combined discharge rating consisted of three components: the flow through the principal spillway, the flow through the emergency spillway and the flow going over the top of the dam.

a. The principal spillway rating was developed by using the weir and full conduit flow equations:

- (1) Weir flow equation ($Q = CLH^{1.5}$)
where C = weir coefficient = 3.1
 L = effective weir length, ft. = 18.85
 H = total head, ft.

- (2) Full conduit flow equation

$$Q = a \sqrt{\frac{2gH}{a + K_e + K_b + K_p L}}$$

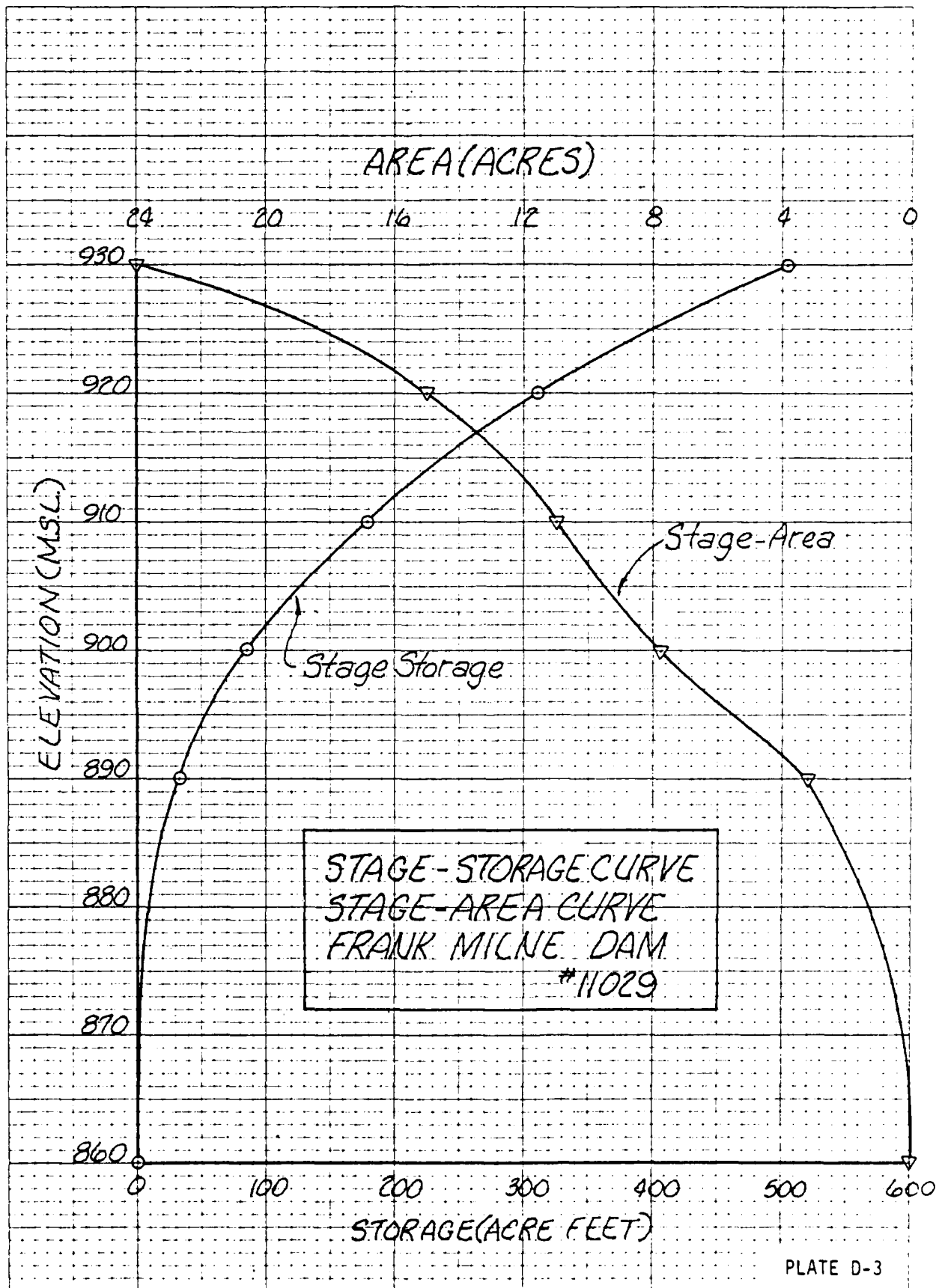
where a = cross-sectional area of pipe, $\text{ft}^2 = 11.4^*$
 H = total head, ft.
 K_e = coefficient for entrance loss = 0.5
 K_b = coefficient for bend loss = 0.75
 K_p = coefficient for pipe friction loss = 0.0749
 L = length of pipe, ft. = 150

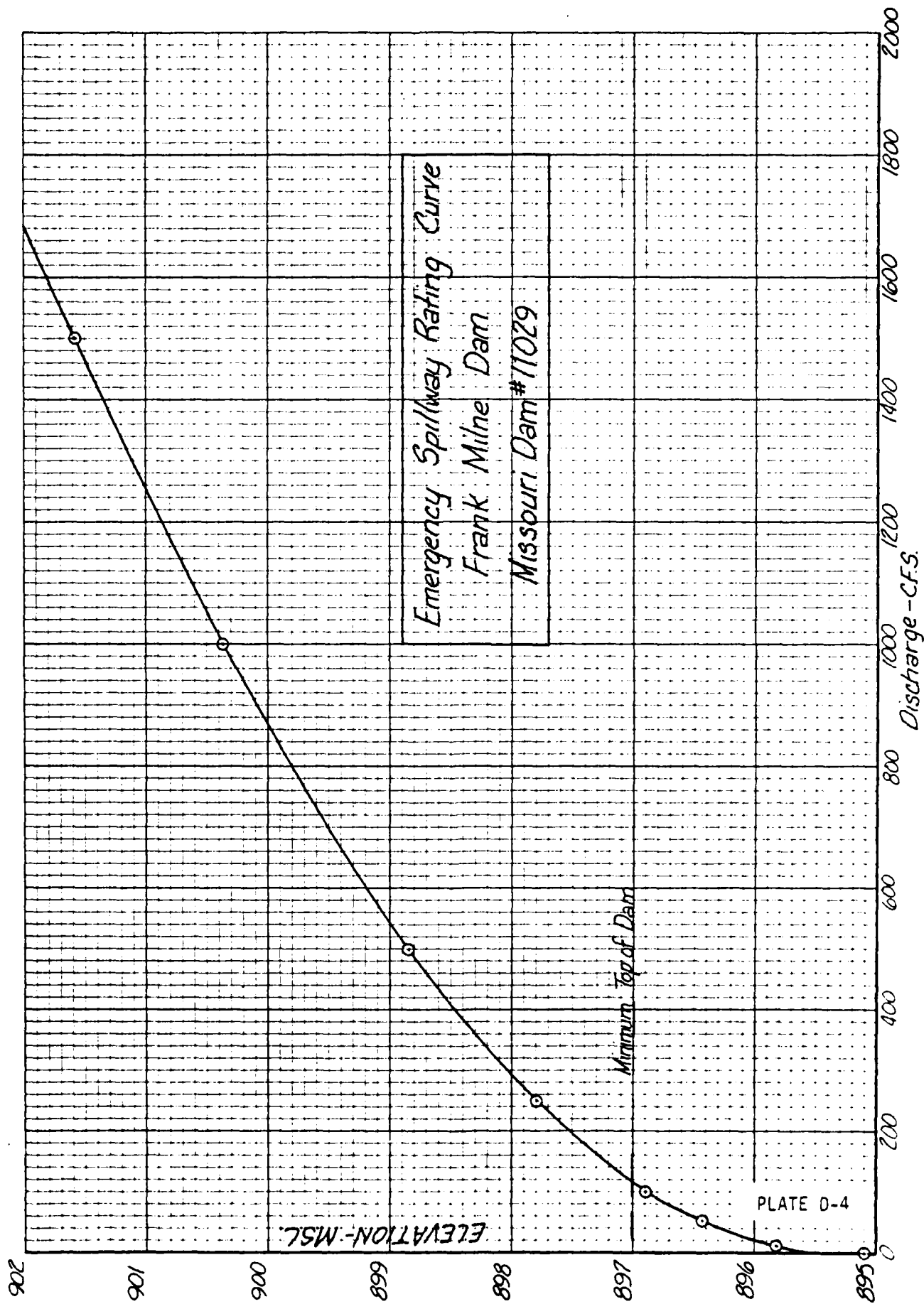
* Note: area of pipe assumed to be equivalent to a 48-inch equivalent arch (58 inch span, 36 inch rise).

b. The emergency spillway ratings was developed using the Corps of Engineers Surface Water Profile HEC-2 computer program.

c. The flows over the dam are based on the broad-crested weir equation ($Q = CLH^{1.5}$) where H is the head on the dam crest, L is the effective length acting as a weir, and C is an appropriate weir coefficient which varies with head and is based on U.S. Geological Survey criteria. The weir coefficient varied from 2.54 to 3.05 and the effective length used was 50 feet and an overall length of 418 feet.

3. Floods were routed through the reservoir using the HEC-1 (Dam Safety Version) program to determine the capabilities of the spillway and dam embankment crest. The input and output data and plotted hydrographs for 5%, 50% and 100% of the PMF are attached in this section.





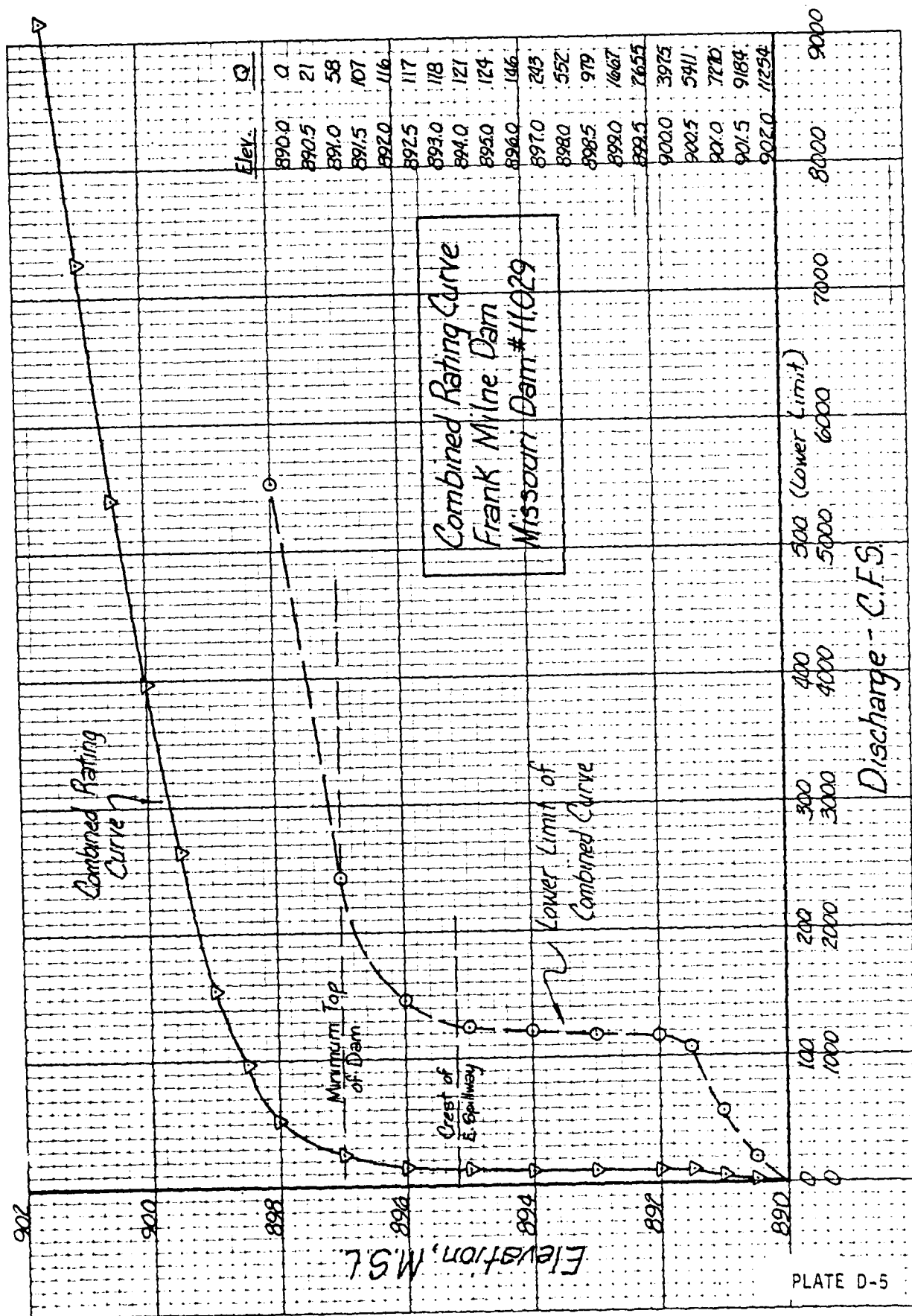


PLATE D-5

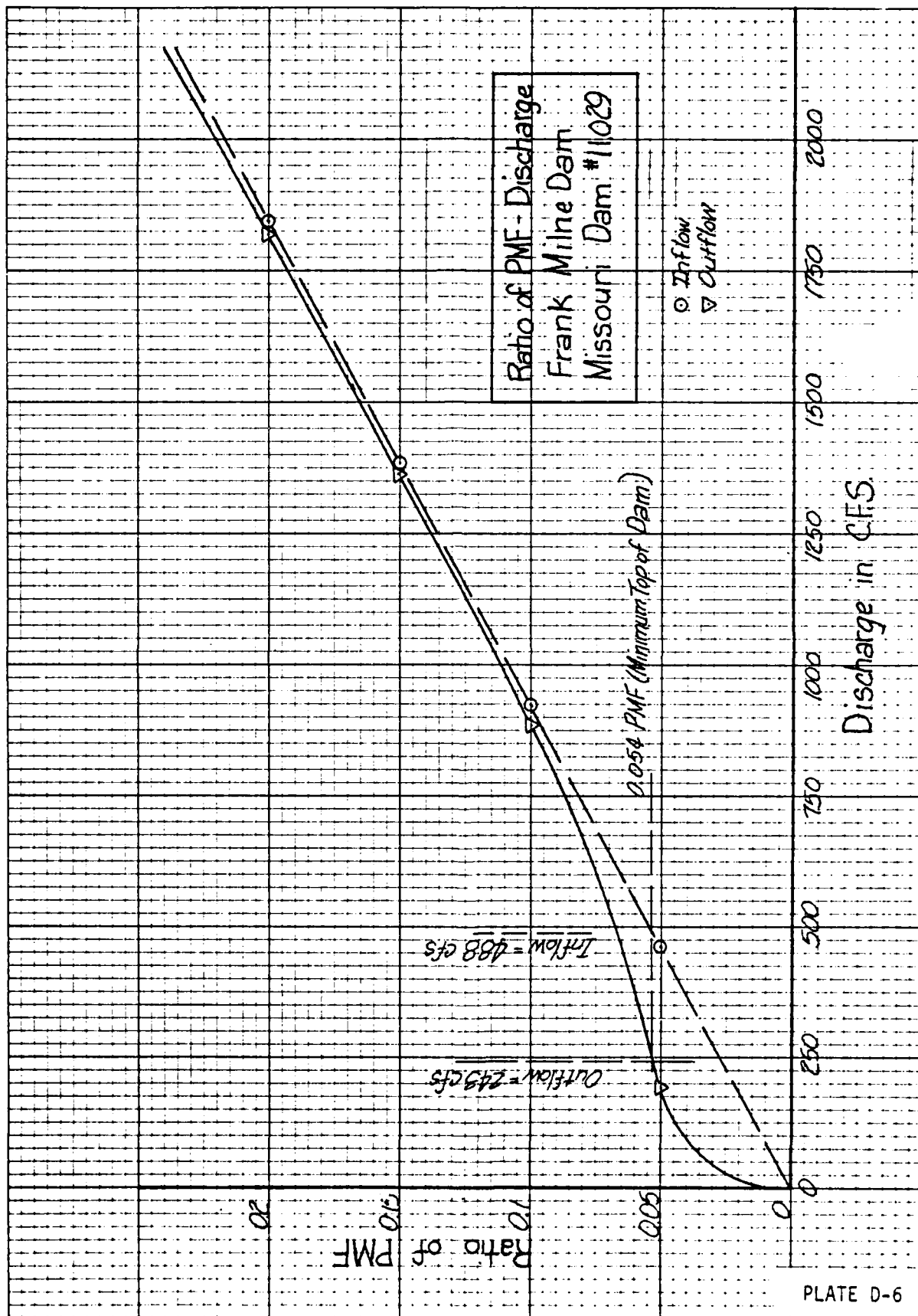


PLATE D-6

[illegible]

 FLOOD HYDROGRAPH PACKAGE (HEC-1)
 DAM SAFETY VERSION JULY 1978
 LAST MODIFICATION 26 FEB 79

RUN DATE 79/09/11.
 TIME 17.40.31.

PMF Output Data

ANALYSIS OF DAM OVERTOPPING USING RATIOS OF PMF
 HYDROLOGIC-HYDRAULIC ANALYSIS OF SAFETY OF FRANK MILNE DAM 11029
 RATIOS OF PMF ROUTED THROUGH THE RESERVOIR

JOB SPECIFICATION									
RQ	NR	NPIN	IDAY	INR	IMIN	MTRC	IPRT	IPRT	NSIAN
288	0	5	0	0	0	0	0	3	0
JUPER NWT IROPT TRACE									
5 0 0 0									

MULTI-PLAN ANALYSES TO BE PERFORMED

NPLAN= 1 NRTIO= 8 LRTIO= 1
 RTIOS= .05 .10 .15 .20 .30 .40 .50 1.00

SUB-AREA RUNOFF COMPUTATION

CALCULATION OF INFLOW HYDROGRAPH TO 11029 RES

ISTAQ	ICOMP	IECUN	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUD
000001	0	0	0	0	0	1	0	0

HYDROGRAPH DATA

INVDG	INUG	ITRGA	SNAP	TRSDA	TRSPC	RATIO	ISNUM	ISAME	LOCAL
1	2	1.36	0.00	1.36	1.00	0.000	0	1	0

PRECIP DATA

SPFE	PMS	RE	R12	R24	R48	R72	R96
C.00	24.00	102.00	121.00	130.00	0.00	0.00	0.00

LOSS DATA

CRUPT	STPRR	DLTR	RTIOL	ERAIN	STPKS	RTIOK	STRTL	CNSTL	ALSMX	KTEMP
0	0.00	0.00	1.00	0.00	0.00	1.00	-1.00	-78.00	0.00	0.00

CORVE PM = -78.00 WEINFS = -1.00 EFFECT CN = 78.00

UNIT HYDROGRAPH DATA

IC= 0.00 LAG= .50

RECESSION DATA

STRTU= 0.00 QRCOSH= -.01 RTIOH= 1.00

UNIT HYDROGRAPH 32 END OF PIPED ORIGINATES, TC= 0.00 HROPS, LAG= .50 VOL= 1.00									
92.	241.	493.	827.	1033.	1199.	1199.	1097.	957.	766.
565.	330.	270.	211.	163.	126.	99.	77.	59.	5.
46.	28.	22.	17.	13.	11.	9.	7.	5.	5.

.....

REQUIRED FLOWS THRU 11029 RES

1995	890.00	890.50	891.00	891.50	892.00	892.50	893.00	894.00	895.00	896.00	897.00	898.00	899.00	900.00	901.00	902.00	903.00	904.00	905.00	906.00	907.00	908.00	909.00	910.00	911.00	912.00	913.00	914.00	915.00	916.00	917.00	918.00	919.00	920.00	921.00	922.00	923.00	924.00	925.00	926.00	927.00	928.00	929.00	930.00	931.00	932.00	933.00	934.00	935.00	936.00	937.00	938.00	939.00	940.00	941.00	942.00	943.00	944.00	945.00	946.00	947.00	948.00	949.00	950.00	951.00	952.00	953.00	954.00	955.00	956.00	957.00	958.00	959.00	960.00	961.00	962.00	963.00	964.00	965.00	966.00	967.00	968.00	969.00	970.00	971.00	972.00	973.00	974.00	975.00	976.00	977.00	978.00	979.00	980.00	981.00	982.00	983.00	984.00	985.00	986.00	987.00	988.00	989.00	990.00	991.00	992.00	993.00	994.00	995.00	996.00	997.00	998.00	999.00	1000.00
1996	0.00	21.00	58.00	107.00	116.00	117.00	118.00	121.00	124.00	126.00	127.00	128.00	129.00	130.00	131.00	132.00	133.00	134.00	135.00	136.00	137.00	138.00	139.00	140.00	141.00	142.00	143.00	144.00	145.00	146.00	147.00	148.00	149.00	150.00	151.00	152.00	153.00	154.00	155.00	156.00	157.00	158.00	159.00	160.00	161.00	162.00	163.00	164.00	165.00	166.00	167.00	168.00	169.00	170.00	171.00	172.00	173.00	174.00	175.00	176.00	177.00	178.00	179.00	180.00	181.00	182.00	183.00	184.00	185.00	186.00	187.00	188.00	189.00	190.00	191.00	192.00	193.00	194.00	195.00	196.00	197.00	198.00	199.00	200.00																														

(CAPACITY =	0.	32.	85.	179.	310.	504.
-------------	----	-----	-----	------	------	------

FLU VARIUM=	86C.	890.	900.	910.	920.	930.
-------------	------	------	------	------	------	------

CRI	SPWID	CCQM	EXPM	ELEV	COOL	CAREA	FXPL
820.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DAM DATA		
ICPEL	COOD	EXPO
897.0	3.0	1.5
		DAMHIO
		0.

STATION 000002, PLAN 1, RATIO 1

END-OF-PEAK HYDROGRAPH ORDINATE;

WUTSICW

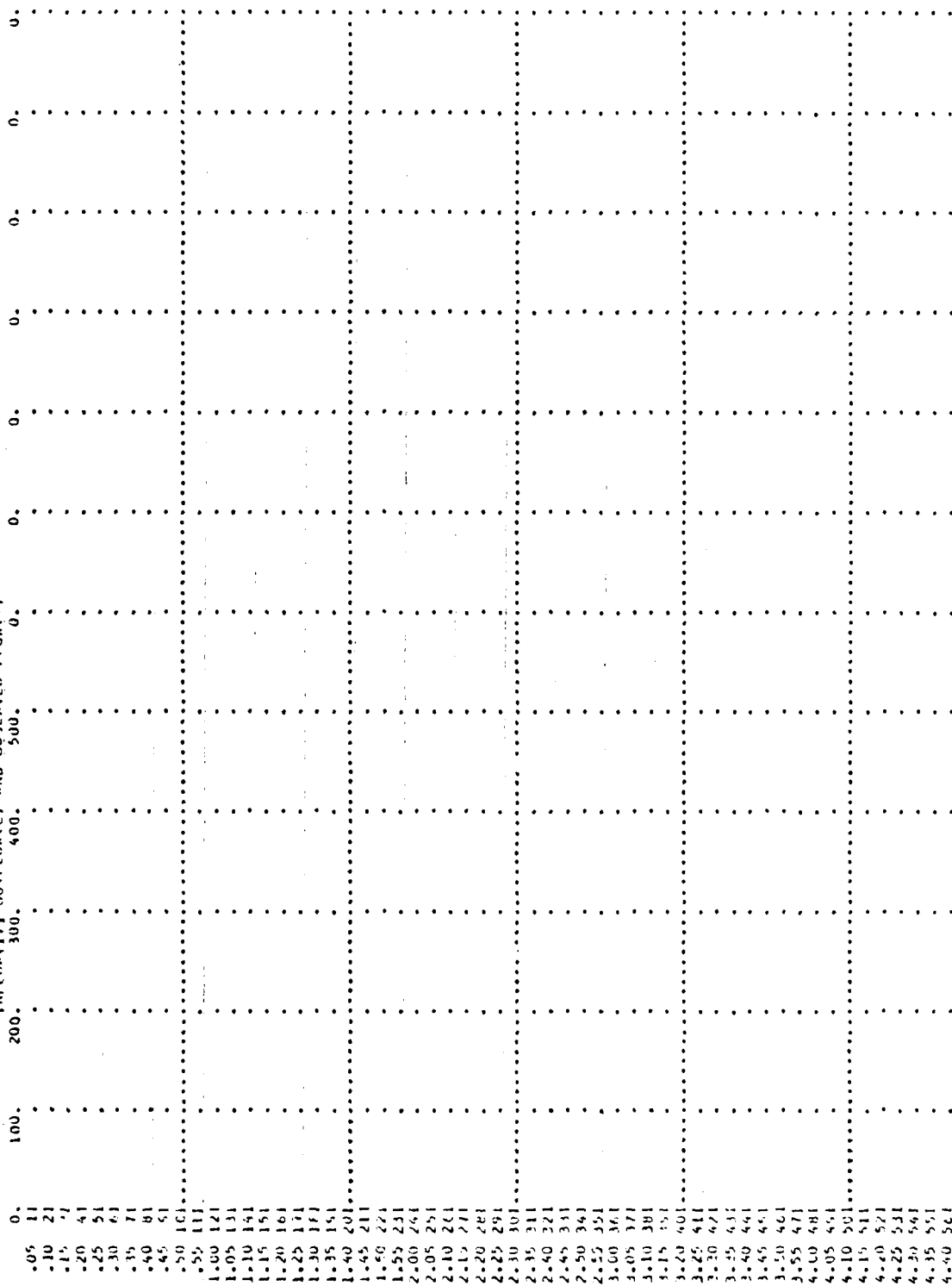
0.05 PMF

[illegible]

0.05 Inflow & Outflow Hydrographs

STATION 0000002

INFLUW(1), OUTFLOW(1) AND OBSERVED FLOW(1)



4.45 571
 4.50 581
 4.55 591
 5.00 601
 5.05 611
 5.10 621
 5.15 631
 5.20 641
 5.25 651
 5.30 661
 5.35 671
 5.40 681
 5.45 691
 5.50 701
 5.55 711
 6.00 721
 6.05 731
 6.10 741
 6.15 751
 6.20 761
 6.25 771
 6.30 781
 6.35 791
 6.40 801
 6.45 811
 6.50 821
 6.55 831
 7.00 841
 7.05 851
 7.10 861
 7.15 871
 7.20 881
 7.25 891
 7.30 901
 7.35 911
 7.40 921
 7.45 931
 7.50 941
 7.55 951
 8.00 961
 8.05 971
 8.10 981
 8.15 991
 8.20 1001
 8.25 1011
 8.30 1021
 8.35 1031
 8.40 1041
 8.45 1051
 8.50 1061
 8.55 1071
 9.00 1081
 9.05 1091
 9.10 1101
 9.15 1111
 9.20 1121
 9.25 1131
 9.30 1141
 9.35 1151
 9.40 1161
 9.45 1171
 9.50 1181

STATION 000002, PLAN 1, RATIO 7
END-OF-PERIOD HYDROGRAPH ORDINATES

0.5 Inflow & Outflow Hydrographs

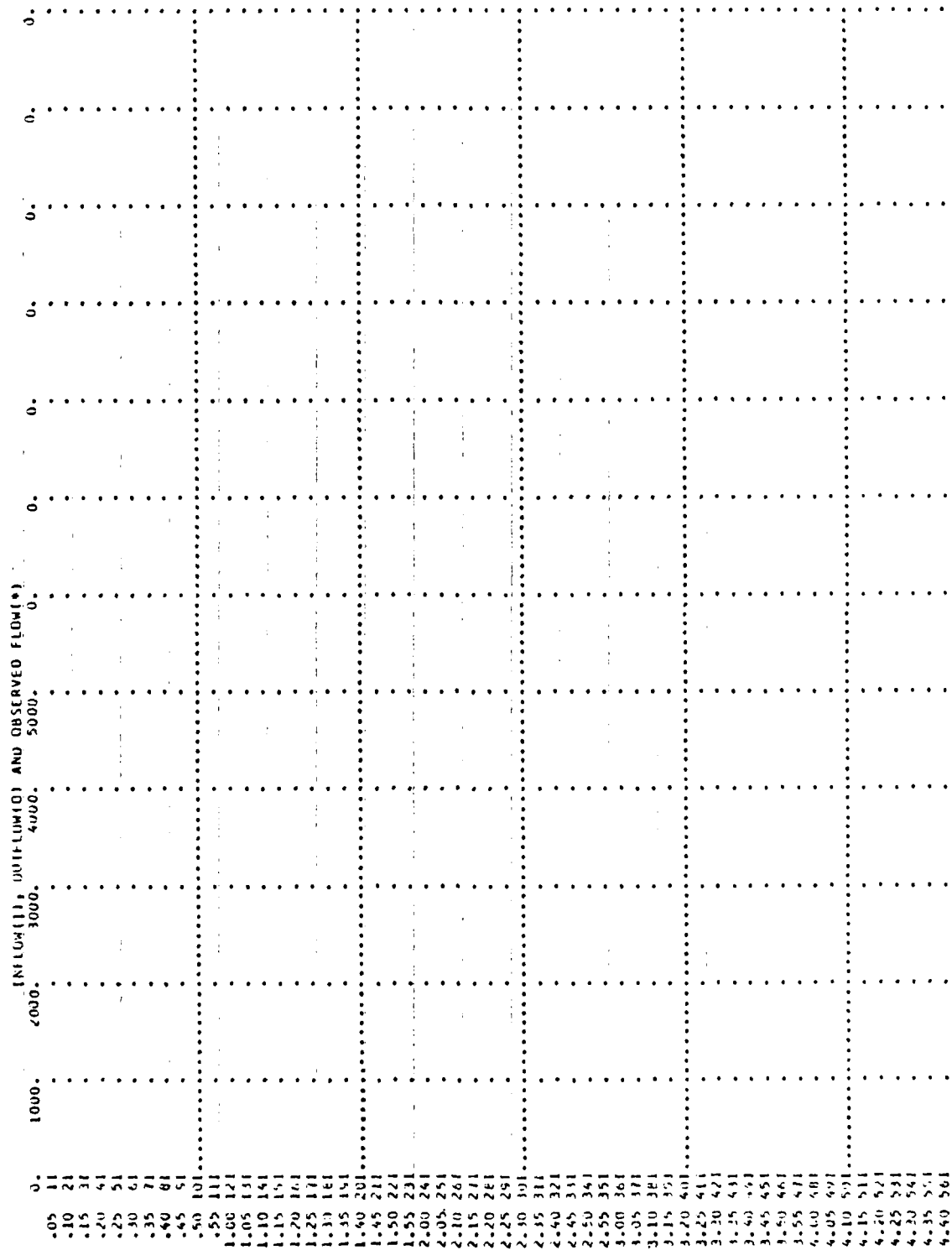
OUTFLOW									
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
1.	2.	2.	2.	3.	3.	3.	3.	3.	4.
4.	5.	6.	7.	8.	10.	13.	16.	16.	16.
26.	42.	50.	58.	68.	77.	86.	95.	95.	95.
109.	111.	113.	115.	116.	117.	117.	117.	117.	117.
117.	118.	118.	119.	119.	120.	120.	121.	121.	121.
121.	122.	123.	123.	124.	126.	129.	133.	133.	133.
136.	147.	154.	166.	176.	185.	193.	201.	201.	201.
203.	214.	220.	225.	234.	241.	248.	256.	256.	256.
267.	271.	276.	282.	287.	292.	297.	302.	302.	302.
316.	321.	326.	331.	336.	341.	347.	352.	352.	352.
366.	371.	376.	381.	386.	391.	396.	401.	401.	401.
416.	421.	426.	431.	436.	441.	446.	451.	451.	451.
466.	471.	476.	481.	486.	491.	496.	501.	501.	501.
516.	521.	526.	531.	536.	541.	546.	551.	551.	551.
566.	571.	576.	581.	586.	591.	596.	601.	601.	601.
616.	621.	626.	631.	636.	641.	646.	651.	651.	651.
666.	671.	676.	681.	686.	691.	696.	701.	701.	701.
716.	721.	726.	731.	736.	741.	746.	751.	751.	751.
766.	771.	776.	781.	786.	791.	796.	801.	801.	801.
816.	821.	826.	831.	836.	841.	846.	851.	851.	851.
866.	871.	876.	881.	886.	891.	896.	901.	901.	901.
916.	921.	926.	931.	936.	941.	946.	951.	951.	951.
966.	971.	976.	981.	986.	991.	996.	1001.	1001.	1001.
1016.	1021.	1026.	1031.	1036.	1041.	1046.	1051.	1051.	1051.
1066.	1071.	1076.	1081.	1086.	1091.	1096.	1101.	1101.	1101.
1116.	1121.	1126.	1131.	1136.	1141.	1146.	1151.	1151.	1151.
1166.	1171.	1176.	1181.	1186.	1191.	1196.	1201.	1201.	1201.
1216.	1221.	1226.	1231.	1236.	1241.	1246.	1251.	1251.	1251.
1266.	1271.	1276.	1281.	1286.	1291.	1296.	1301.	1301.	1301.
1316.	1321.	1326.	1331.	1336.	1341.	1346.	1351.	1351.	1351.
1366.	1371.	1376.	1381.	1386.	1391.	1396.	1401.	1401.	1401.
1416.	1421.	1426.	1431.	1436.	1441.	1446.	1451.	1451.	1451.
1466.	1471.	1476.	1481.	1486.	1491.	1496.	1501.	1501.	1501.
1516.	1521.	1526.	1531.	1536.	1541.	1546.	1551.	1551.	1551.
1566.	1571.	1576.	1581.	1586.	1591.	1596.	1601.	1601.	1601.
1616.	1621.	1626.	1631.	1636.	1641.	1646.	1651.	1651.	1651.
1666.	1671.	1676.	1681.	1686.	1691.	1696.	1701.	1701.	1701.
1716.	1721.	1726.	1731.	1736.	1741.	1746.	1751.	1751.	1751.
1766.	1771.	1776.	1781.	1786.	1791.	1796.	1801.	1801.	1801.
1816.	1821.	1826.	1831.	1836.	1841.	1846.	1851.	1851.	1851.
1866.	1871.	1876.	1881.	1886.	1891.	1896.	1901.	1901.	1901.
1916.	1921.	1926.	1931.	1936.	1941.	1946.	1951.	1951.	1951.
1966.	1971.	1976.	1981.	1986.	1991.	1996.	2001.	2001.	2001.
2016.	2021.	2026.	2031.	2036.	2041.	2046.	2051.	2051.	2051.
2066.	2071.	2076.	2081.	2086.	2091.	2096.	2101.	2101.	2101.
2116.	2121.	2126.	2131.	2136.	2141.	2146.	2151.	2151.	2151.
2166.	2171.	2176.	2181.	2186.	2191.	2196.	2201.	2201.	2201.
2216.	2221.	2226.	2231.	2236.	2241.	2246.	2251.	2251.	2251.
2266.	2271.	2276.	2281.	2286.	2291.	2296.	2301.	2301.	2301.
2316.	2321.	2326.	2331.	2336.	2341.	2346.	2351.	2351.	2351.
2366.	2371.	2376.	2381.	2386.	2391.	2396.	2401.	2401.	2401.
2416.	2421.	2426.	2431.	2436.	2441.	2446.	2451.	2451.	2451.
2466.	2471.	2476.	2481.	2486.	2491.	2496.	2501.	2501.	2501.
2516.	2521.	2526.	2531.	2536.	2541.	2546.	2551.	2551.	2551.
2566.	2571.	2576.	2581.	2586.	2591.	2596.	2601.	2601.	2601.
2616.	2621.	2626.	2631.	2636.	2641.	2646.	2651.	2651.	2651.
2666.	2671.	2676.	2681.	2686.	2691.	2696.	2701.	2701.	2701.
2716.	2721.	2726.	2731.	2736.	2741.	2746.	2751.	2751.	2751.
2766.	2771.	2776.	2781.	2786.	2791.	2796.	2801.	2801.	2801.
2816.	2821.	2826.	2831.	2836.	2841.	2846.	2851.	2851.	2851.
2866.	2871.	2876.	2881.	2886.	2891.	2896.	2901.	2901.	2901.
2916.	2921.	2926.	2931.	2936.	2941.	2946.	2951.	2951.	2951.
2966.	2971.	2976.	2981.	2986.	2991.	2996.	3001.	3001.	3001.
3016.	3021.	3026.	3031.	3036.	3041.	3046.	3051.	3051.	3051.
3066.	3071.	3076.	3081.	3086.	3091.	3096.	3101.	3101.	3101.
3116.	3121.	3126.	3131.	3136.	3141.	3146.	3151.	3151.	3151.
3166.	3171.	3176.	3181.	3186.	3191.	3196.	3201.	3201.	3201.
3216.	3221.	3226.	3231.	3236.	3241.	3246.	3251.	3251.	3251.
3266.	3271.	3276.	3281.	3286.	3291.	3296.	3301.	3301.	3301.
3316.	3321.	3326.	3331.	3336.	3341.	3346.	3351.	3351.	3351.
3366.	3371.	3376.	3381.	3386.	3391.	3396.	3401.	3401.	3401.
3416.	3421.	3426.	3431.	3436.	3441.	3446.	3451.	3451.	3451.
3466.	3471.	3476.	3481.	3486.	3491.	3496.	3501.	3501.	3501.
3516.	3521.	3526.	3531.	3536.	3541.	3546.	3551.	3551.	3551.
3566.	3571.	3576.	3581.	3586.	3591.	3596.	3601.	3601.	3601.
3616.	3621.	3626.	3631.	3636.	3641.	3646.	3651.	3651.	3651.
3666.	3671.	3676.	3681.	3686.	3691.	3696.	3701.	3701.	3701.
3716.	3721.	3726.	3731.	3736.	3741.	3746.	3751.	3751.	3751.
3766.	3771.	3776.	3781.	3786.	3791.	3796.	3801.	3801.	3801.
3816.	3821.	3826.	3831.	3836.	3841.	3846.	3851.	3851.	3851.
3866.	3871.	3876.	3881.	3886.	3891.	3896.	3901.	3901.	3901.
3916.	3921.	3926.	3931.	3936.	3941.	3946.	3951.	3951.	3951.
3966.	3971.	3976.	3981.	3986.	3991.	3996.	4001.	4001.	4001.
4016.	4021.	4026.	4031.	4036.	4041.	4046.	4051.	4051.	4051.
4066.	4071.	4076.	4081.	4086.	4091.	4096.	4101.	4101.	4101.
4116.	4121.	4126.	4131.	4136.	4141.	4146.	4151.	4151.	4151.
4166.	4171.	4176.	4181.	4186.	4191.	4196.	4201.	4201.	4201.
4216.	4221.	4226.	4231.	4236.	4241.	4246.	4251.	4251.	4251.
4266.	4271.	4276.	4281.	4286.	4291.	4296.	4301.	4301.	4301.
4316.	4321.	4326.	4331.	4336.	4341.	4346.	4351.	4351.	4351.
4366.	4371.	4376.	4381.	4386.	4391.	4396.	4401.	4401.	4401.
4416.	4421.	4426.	4431.	4436.	4441.	4446.	4451.	4451.	4451.
4466.	4471.	4476.	4481.	4486.	4491.	4496.	4501.	4501.	4501.
4516.	4521.	4526.	4531.	4536.	4541.	4546.	4551.	4551.	4551.
4566.	4571.	4576.	4581.	4586.	4591.	4596.	4601.	4601.	4601.
4616.	4621.	4626.	4631.	4636.	4641.	4646.	4651.	4651.	4651.
4666.	4671.	4676.	4681.	4686.	4691.	4696.	4701.	4701.	4701.
4716.	4721.	4726.	4731.	4736.	4741.	4746.	4751.	4751.	4751.
4766.	4771.	4776.	4781.	4786.	4791.	4796.	4801.	4801.	4801.
4816.	4821.	4826.	4831.	4836.	4841.	4846.	4851.	4851.	4851.
4866.	4871.	4876.	4881.	4886.	4891.	4896.	4901.	4901.	4901.
4916.	4921.	4926.	4931.	4936.	4941.	4946.	4951.	4951.	4951.
4966.	4971.	4976.	4981.	4986.	4991.	4996.	5001.	5001.	5001.
5016.	5021.	5026.	5031.	5036.	5041.	5046.	5051.	5051.	5051.
5066.	5071.	5076.	5081.	5086.	5091.	5096.	5101.	5101.	5101.
5116.	5121.	5126.	5131.	5136.	5141.	5146.	5151.	5151.	5151.
5166.	5171.	5176.	5181.	5186.	5191.	5196.	5201.	5201.	5201.
5216.	5221.	5226.	5231.	5236.	5241.	5246.	5251.	5251.	5251.
5266.	5271.	5276.	5281.	5286.	5291.	5296.	5301.	5301.	5301.
5316.	5321.	5326.	5331.	5336.	5341.	5346.	5351.	5351.	5351.
5366.	5371.	5376.	5381.	5386.	5391.	5396.	5401.	5401.	5401.
5416.	5421.	5426.	5431.	5436.	5441.	5446.	5451.	5451.	5451.
5466.	5471.	5476.	5481.	5486.	5491.	5496.	5501.	5501.	5501.
5516.	5521.	5526.	5531.	5536.	5541.	5546.	5551.	5551.	5551.
5566.	5571.	5576.	5581.	5586.	5591.	5596.	5601.	5601.	5601.
5616.	5621.	5626.	5631.	5636.	5641.	5646.	5651.	5651.	5651.
5666.	5671.	5676.	5681.	5686.	5691.	5696.	5701.	5701.	5701.
5716.	5721.	5726.	5731.	5736.	5741.	5746.	5751.	5751.	5751.
5766.	5771.	5776.	5781.	5786.	5791.	5796.	5801.	5801.	5801.
5816.	5821.	5826.	5831.	5836.	5841.	5846.	5851.	5851.	5851.
5866.	5871.	5876.	5881.	5886.	5891.	5896.	5901.	5901.	5901.
5916.	5921.	5926.	5931.	5936.	5941.	5946.	5951.	5951.	5951.
5966.	5971.	5976.	5981.	5986.	5991.	5996.	6001.	6001.	6001.
6016.	6021.	6026.	6031.	6036.	6041.	6046.	6051.	6051.	6051.
6066.	6071.	6076.	6081.	6086.	6091.	6096.	6101.	6101.	6101.
6116.	6121.	6126.	6131						

PEARL HARBOR IS 4611. AT TIME 16-03 HOURS

PLATE D-18

•LVI•

STATION000002



4.45 5.11
4.50 5.81
4.55 5.91
5.00 6.31
5.05 6.11
5.10 6.21
5.15 6.31
5.20 6.41
5.25 6.51
5.30 6.61
5.35 6.71
5.40 6.81
5.45 6.91
5.50 7.01
5.55 7.11
6.00 7.21
6.05 7.31
6.10 7.41
6.15 7.51
6.20 7.61
6.25 7.71
6.30 7.81
6.35 7.91
6.40 8.01
6.45 8.11
6.50 8.21
6.55 8.31
7.00 8.41
7.05 8.51
7.10 8.61
7.15 8.71
7.20 8.81
7.25 8.91
7.30 9.01
7.35 9.11
7.40 9.21
7.45 9.31
7.50 9.41
7.55 9.51
8.00 9.61
8.05 9.71
8.10 9.81
8.15 9.91
8.20 10.01
8.25 10.11
8.30 10.21
8.35 10.31
8.40 10.41
8.45 10.51
8.50 10.61
8.55 10.71
9.00 10.81
9.05 10.91
9.10 11.01
9.15 11.11
9.20 11.21
9.25 11.31
9.30 11.41
9.35 11.51
9.40 11.61
9.45 11.71
9.50 11.81

PLATE D-22

20.15241.1
 20.20244.1
 20.25245.1
 20.30246.1
 20.35247.1
 20.40248.1
 20.45249.1
 20.50250.1
 20.55251.1
 21.00252.1
 21.05253.1
 21.10254.1
 21.15255.1
 21.20256.1
 21.25257.1
 21.30258.1
 21.35259.1
 21.40260.1
 21.45261.1
 21.50262.1
 21.55263.1
 22.00264.1
 22.05265.1
 22.10266.1
 22.15267.1
 22.20268.1
 22.25269.1
 22.30270.1
 22.35271.1
 22.40272.1
 22.45273.1
 22.50274.1
 22.55275.1
 23.00276.1
 23.05277.1
 23.10278.1
 23.15279.1
 23.20280.1
 23.25281.1
 23.30282.1
 23.35283.1
 23.40284.1
 23.45285.1
 23.50286.1
 23.55287.1
 24.00288.1

STATION 000002, PLAN 1, RATIO 8
END-01--PERIOD HYDROGRAPH URDINATES
1.0 PMF

[illegible][illegible]

PEAK UNIFLOW IS 9240. AT TIME 16.03 HOURS

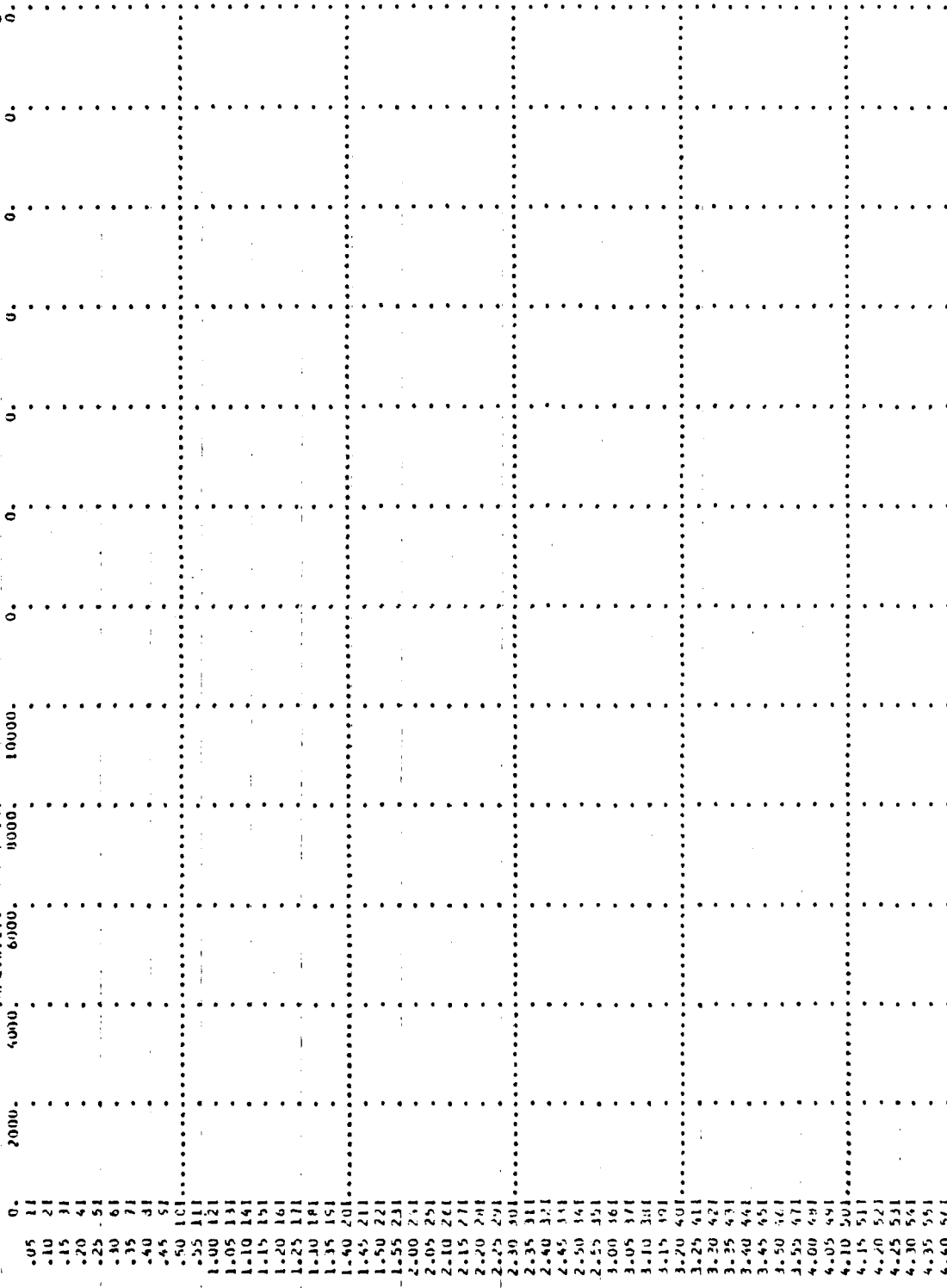
PLATE D-25

0001

STATION 00002

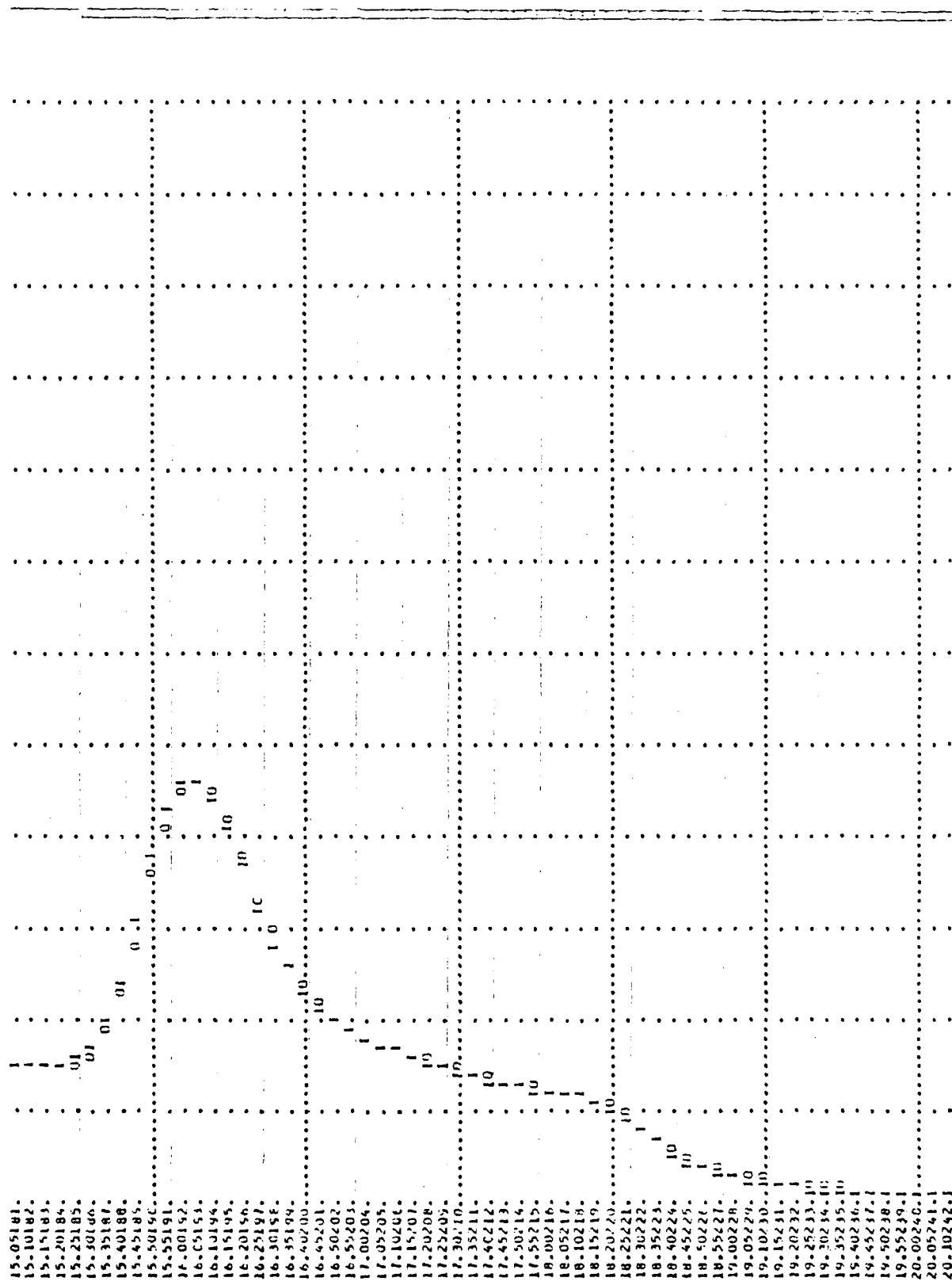
1.0 PMF Inflow & Outflow Hydrographs

INFLOW (CFS), INFLUENCE (CFS) AND OBSERVED FLOW (CFS)



4.45 571
 4.50 581
 4.55 591
 5.00 601
 5.05 611
 5.10 621
 5.15 631
 5.20 641
 5.25 651
 5.30 661
 5.35 671
 5.40 681
 5.45 691
 5.50 701
 5.55 711
 6.00 721
 6.05 731
 6.10 741
 6.15 751
 6.20 761
 6.25 771
 6.30 781
 6.35 791
 6.40 801
 6.45 8101
 6.50 8201
 6.55 8301
 7.00 8401
 7.05 85.1
 7.10 86.1
 7.15 87.1
 7.20 88.1
 7.25 89.1
 7.30 90.1
 7.35 91.1
 7.40 92.01
 7.45 93.01
 7.50 94.01
 7.55 95.01
 8.00 96.01
 8.05 97.01
 8.10 98.01
 8.15 99.01
 8.20 100.01
 8.25 101.01
 8.30 102.01
 8.35 103.01
 8.40 104.01
 8.45 105.01
 8.50 106.01
 8.55 107.1
 9.00 108.1
 9.05 109.1
 9.10 110.1
 9.15 111.1
 9.20 112.1
 9.25 113.1
 9.30 114.1
 9.35 115.1
 9.40 116.1
 9.45 117.1
 9.50 118.1

9.55119.	1
10.00120.	1
10.05121.	01
10.10122.	01
10.15123.	01
10.20124.	01
10.25125.	1
10.30126.	1
10.35127.	1
10.40128.	1
10.45129.	1
10.50130.	1
10.55131.	1
11.00132.	1
11.05133.	1
11.10134.	1
11.15135.	1
11.20136.	1
11.25137.	1
11.30138.	1
11.35139.	1
11.40140.	1
11.45141.	1
11.50142.	1
11.55143.	1
12.00144.	1
12.05145.	1
12.10146.	1
12.15147.	1
12.20148.	01
12.25149.	01
12.30150.	01
12.35151.	01
12.40152.	01
12.45153.	1
12.50154.	01
12.55155.	1
13.00156.	01
13.05157.	1
13.10158.	1
13.15159.	1
13.20160.	1
13.25161.	1
13.30162.	1
13.35163.	01
13.40164.	1
13.45165.	1
13.50166.	1
13.55167.	01
14.00168.	1
14.05169.	1
14.10170.	1
14.15171.	1
14.20172.	1
14.25173.	1
14.30174.	1
14.35175.	01
14.40176.	1
14.45177.	1
14.50178.	01
14.55179.	1
15.00180.	1



[illegible]

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
 FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
 AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIOS APPLIED TO FLOWS							
				RATIO 1	RATIO 2	RATIO 3	RATIO 4	RATIO 5	RATIO 6	RATIO 7	RATIO 8
				.05	.10	.15	.20	.30	.40	.50	1.00
HYDROGRAPH AT	000001	1.36 (3.51)	1	461.	923.	1384.	1845.	2768.	3690.	4613.	9226.
				13.06(1)	26.13(1)	39.19(1)	52.25(1)	78.38(1)	104.50(1)	130.63(1)	261.25(1)
CALCULATED TO	000002	1.36 (3.51)	1	188.	892.	1362.	1836.	2769.	3687.	4611.	9240.
				5.31(1)	24.96(1)	38.57(1)	51.98(1)	78.42(1)	104.40(1)	130.57(1)	261.65(1)

PLAN 1

PLATE D-32

**DA
FILM**